Diesel Electric Generator General Permit - GP-1
Facility Category Analysis

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Electric Utility: SIC Codes 4911 and 4931.

Processes and Products

Diesel-engine powered electric generators are the sole source of electric power for many communities in rural Alaska. Utilities in rural communities have primary and backup generator sets to accommodate peak power demands, and to provide uninterrupted service during scheduled and unscheduled maintenance.

Emission sources include diesel engines and fuel storage tanks.

Some utilities that use diesel engines to power their generators may also produce power with gas turbines or boilers.

SIP and Operating Permit Regulatory Classifications

There are two possible operating permit classifications to evaluate for operation under the diesel generator general permit.

1) AS 46.14.130(b)(1), & 18 AAC 50.325(b)(1): The first is classification is for facilities emitting or having the potential to emit 100 tons per year or more of a regulated air contaminant.

2) AS 46.14.130(b)(4), & 18 AAC 50.325(c): The second is for SIP facilities. There are several SIP categories to evaluate for electric utilities using diesel power. While several categories may apply to facilities containing diesel generators, the general permit may not be usable for them.

   - 18 AAC 50.300(c)(1). A facility that emits or has the potential to emit (PTE) 250 TPY or more of a regulated air contaminant. This permit could be used if the facility was built before PSD rules were in effect and has not had a major modification.

     PSD and PSD-avoiding facilities cannot use the general permit because they have facility-specific emission limits.

   - 18 AAC 50.300(b)(2). A facility containing fuel burning equipment with a rated

capacity of 100 MMBtu/hr or more.

100 MMBtu/hr equates to 39,290 hp at 100% engine efficiency. Even accounting for the energy efficiency of the engine, this would be bigger than a diesel used by a rural community for power generation.

A facility containing a diesel generator could contain some other 100 MMBtu/hr fuel burning equipment that subjects the facility to permitting. However this permit could not be used if that equipment is

- a 250 MMBTU/hr steam generating unit built after August 17, 1971;
- any other 100 MMBTU/hr or larger steam generating unit built after June 19, 1984; or
- a gas turbine built after October 3, 1977.

New Source Performance Standards apply to these sources. The NSPS are not part of the general permit.

C 18 AAC 50.300(b)(6)(B). A facility that commences construction in a sulfur dioxide special protection area on or after January 18, 1997, that contains a source with a rated capacity of 10 million Btu/hr or more.

Facilities in this classification cannot use the general permit. Saint Paul and Dutch Harbor/Unalaska have been predicted to have ambient air quality problems. Emission reductions have been required from existing sources to improve air quality. An ambient demonstration and source-specific emissions limits would be needed for any new source moving into the area. Source-specific limits can not be included in a general permit.

C 18 AAC 50.300(d) or (e). A facility that emits or has the potential to emit 100 TPY or more of a nonattainment air contaminant and is in, or within 10 kilometers of, the nonattainment area.

The general permit could not be used. The facility would have a case by case emission limitation for protection of ambient air.

For simplicity, GP-1 and its application form do not list SIP classifications which are based on emissions of 100 or 250 tons per year. These are redundant to 18 AAC 50.325(b)(1).

List of Qualifying Criteria

#1. No facility-specific requirements apply.

#2. No equipment at the facility is subject to an NSPS, NESHAP, or other federal emission standard not contained in the permit.

#3. The facility does not contain an incinerator, and no open burning occurs at the facility.

#4. Of the standards in 18 AAC 50.055(a) - (f), only (a)(1), (b)(1), and (c) apply.

#5. If a new facility contains fuel burning equipment, including any stationary diesel, with an individual heat input rating of 10 MMBTU/hr or more, it is not located in a sulfur dioxide special protection area.

Qualifying Criteria - Basis and Need

#1. No facility-specific requirements apply.

The general permit can be used only if no facility-specific requirement applies to the facility through a construction permit under 18 AAC 50.300 - 320, or through a permit issued under the former 18 AAC 50.400. Facility-specific requirements are:

- A BACT requirement
- A LAER requirement or a limitation to provide offsets in a nonattainment area
- A previously determined limit that is specific to the facility and used to comply with:
  - ambient air quality standards;
  - maximum allowable ambient concentrations; or
  - 18 AAC 50.110, protection of public health or welfare
- Emission trading
- A limit to avoid a requirement.

The most common facility-specific requirements are BACT limits, and limits on fuel quantity, fuel quality, or hours of operation to avoid PSD permitting or to comply with an ambient standard or increment.

This criterion is basic to the idea of a general permit. A general permit is usable only where requirements in the permit apply to all facilities in a defined group or subgroup.

Facility-specific requirements do **not** include permit conditions which may apply to a class of facilities and are intended to assure compliance with emission standards in regulation. Examples [from other kinds of facilities] of conditions which are **not** facility specific under 18 AAC 50.350 are:

- to prevent emissions which could harm human health or welfare (18 AAC 50.110)
  -- a 100 ppm carbon monoxide limit on soil remediation unit afterburners as a good combustion practice; or,
- for a facility with a venturi scrubber used to comply with a particulate emission limit (18 AAC 50.055(b)(1))
  -- maintaining adequate pressure drop across the scrubber.

#2. No equipment at the facility is subject to a federal New Source Performance Standard, NESHAP, or other federal emission standard, except

1) A fuel storage tank subject only to a record keeping requirement under Subpart Kb, '116b(a) and (b)--Section 116b(a) and (b) record keeping is in the permit. Actual equipment standards or other limitations of K, Ka, and Kb are not;
2) Asbestos demolition/renovation--40 C.F.R. 61.145 is included as a standard condition;
3) Refrigerant handling of 40 C.F.R. 82.150--this is also included as a standard condition; and
(4) Wood-fired heating devices--the NSPS does not include limitations on the operator.

A permit or permits used by a facility must contain all of the requirements that apply to sources at the facility.

NSPS sources that could be present at a diesel electric facility are gas turbines, NSPS boilers, and Subpart K, Ka, or Kb fuel storage tanks.

A. A facility with a gas turbine cannot operate under this permit.
Some electric generating facilities that use diesels, also use gas turbines. A facility containing a gas turbine constructed, modified, or reconstructed after October 3, 1977 with a 10 MMBTU/hr heat input capacity is subject to 40 C.F.R. 60, Subpart GG. This standard is not included in the general permit.

B. A facility with an NSPS boiler cannot operate under this permit.
Subparts D-Dc, which are complex rules, are not included in the general permit. They apply to steam boilers
- with a heat input capacity of 250 MMBTU/hr, constructed after September 18, 1978;
- with a heat input capacity of 100 MMBTU/hr, constructed after June 19, 1984; or
- with a heat input capacity of 10 MMBTU/hr, constructed after June 9, 1989;

C. A facility with fuel storage tanks subject to control requirements under NSPS Subparts K, Ka, or Kb
All diesel electric generating facilities will have fuel storage tanks for diesel fuel. Since facilities which have actual emissions greater than 100 tons of a regulated air contaminant will burn more than 300,000 gallons per year, we expect that fuel tanks may exceed 20,000 to 40,000 gallons capacities. If a fuel stored is more volatile than #1 fuel oil or diesel oil, it may have a Reid Vapor Pressure (RVP) greater than 1.0 psia. Storage of fuels with an RVP of 1.0 or more in tanks built after June 11, 1973 may be subject to an equipment standard or record keeping under Subparts K or Ka. Storage of fuels with a maximum monthly average vapor pressure greater than 0.5 psia in tanks built after July 23, 1984 may be subject to Subpart Kb.

Only a record of tank size is required for Some Kb tanks--those that are between 10,000 and 20,000 gallons, and larger tanks with low volatility fuel. This permit may be used for those tanks. Other requirements of Subparts K, Ka, and Kb are not included in the permit, so this permit may not be used for tanks subject to them.

#3 and #4. No state emission standards apply to a facility that can use GP-1 except standards included in the permit.

The general permit contains standards for fuel burning equipment or industrial processes. These are general opacity, particulate matter, and SO_2 standards found in 18 AAC 50.055(a)(1), (b)(1), and (c).

The permit does not contain other state standards that were developed for specific fuels or industries. The permit also does not contain standards for incinerators. Therefore, a facility under this permit cannot contain any of these sources.

#5. If a new facility contains fuel burning equipment, including any stationary diesel, with an individual heat input rating of 10 MMBTU/hr or more, it is not located in a sulfur dioxide special protection area.

These special protection areas have had SO_2 ambient air quality problems. A facility with fuel burning equipment larger than 10 MMBTU/hr will either be an existing facility which already has facility-specific permit conditions, or it will be a new facility for which an ambient air quality demonstration is required. Either way, it cannot operate under a general permit.

Qualifying Source Types

This permit applies to facilities with diesel electric generators. All emissions from diesel engines are subject to SIP standards in 18 AAC 50.055.

The facility may include other fuel burning equipment such as space heaters, or boilers not subject to any NSPS. The fuel burning equipment is also subject to 18 AAC 50.055.

The facility will include fuel storage tanks. Tanks not subject to any NSPS requirement, or subject only to the Kb record keeping may operate under this permit.

Tanks larger than 20,000 gallons storing more volatile fuels may be subject to other Subpart K, Ka, or Kb requirements. If so they may not operate under GP-1.

Insignificant emission units may be operated under this permit. The most likely sources are fuel burning equipment and fuel storage.

Regulated Air Contaminants

A permitted diesel generating facility will emit

- SO_2
- NO_x
- Carbon Monoxide

- Particulate matter
- PM-10, and
- VOCs.

Table 1
Permit Requirement Summary Table

Underlying Requirement CitationRequirement		Affected Source	Permit Condition to Assure Compliance	Testing and Monitoring 18 AAC 50.350(g)	Recordkeeping 18 AAC 50.350(h)	Reporting 18 AAC 50.350(i)
18 AAC 50.350(d)(1)(C), 18 AAC 50.325(b)(1), 18 AAC 50.055(b)(1)	Exhaust gas particulate matter concentration shall not exceed 0.05 gr/dscf.	Fuel burning equipment	For diesel engines, and for other fuel burning equipment larger than 10 MMBtu/hr heat input rating, the permittee shall install, maintain, and operate equipment in a manner consistent with a preventive maintenance plan submitted with the application. The plan can be either the manufacturer's recommended procedures or a site specific plan.	Monitoring and and Recordkeeping The permittee shall keep a written maintenance log with sufficient detail to describe maintenance activities performed to comply with the maintenance plan.		Section of Facility Operating Report used to comply with this permit term: (A) (Facility Identification) (B) (Deviations from permit requirements) (C) (Certification by Responsible Official) (D) (Complaint Response)
18 AAC 50.350(d)(1)(C), 18 AAC 50.325(b)(1), 18 AAC 50.055(a)(1)	20% opacity	Fuel burning equipment	Permit Condition Emissions may not reduce visibility through the exhaust effluent by more than 20% averaged over any six consecutive minutes or for a total of three minutes in any one hour	Monitoring For all sources that are not either: insignificant sources, or engines that operate less than 40 hours in the month: A. At least once in each calendar month when the facility is operated, the permittee shall perform a smoke/no-smoke visible emission observation for each piece of equipment. This observation shall determine the presence or absence of any visible smoke in the exhaust effluent. This observation shall me made at operating conditions as near as practicable to the maximum load for the month. To do a smoke/no-smoke observation, the observer does not need to be certified to perform Method 9 readings. B. If visible smoke is detected, the operator shall either repair the source to eliminate visible emissions, and re-inspect within 72 hours, or perform a visible emission observation using Method 9 of 40 C.F.R. 60, Appendix A within 10 days of the initial inspection for the month. The Method 9 observations shall be made at operating conditions as near as practicable to the maximum load for the month.	Keep records of all visible emission observations and copies of the completed Method 9 visible emissions forms (Attachment 1) Record equipment production or operating rate at the time of all visible emissions observations.	Section of Facility Operating Report used to comply with this permit term: (A) (Facility Identification) (B) (Deviations from permit requirements) (C) Certification by Responsible Official (D) Complaint Response (H) Visible emission forms
18 AAC 50.350(d)(1)(C) 18 AAC 50.325(b)(1), 18 AAC 50.055(c)	Emission standard of 500 ppm SO2	Fuel burning equipment	Permit Condition A. Permittee shall not burn	The permittee shall test and keep records of each shipment of fuel oil using Method ASTM D 2880-87, or keep records of ASTM fuel grade.	Permittee shall keep fuel and used oil delivery receipts and	Section of Facility Operating Report used to comply with this permit term:

			any diesel fuel with a sulfur content greater than 0.5 %. B. Permittee shall blend used oil with at least an equal quantity of fuel oil. .		corresponding records of sulfur content. Keep records of how the facility complied with Condition B.	(A) (Facility Identification) (B) (Deviations from permit requirements) (C) (Certification by Responsible Official) (D) (Complaint Response) (F) (Fuel Sulfur) (G) (Used oil blending)
18 AAC 50.350(f)(3), 18 AAC 50.110	No person may permit any emission which is injurious to human health or welfare, animal or plant life, or property, or which would unreasonably interfere with the enjoyment of life or property.	All sources	Permit Condition **[State only requirement]** No person may permit any emission which is injurious to human health or welfare, animal or plant life, or property, or which would unreasonably interfere with the enjoyment of life or property.		Keep a log of all air pollution complaints received, investigations conducted to determine the cause of the complaints, and the actions taken to resolve the complaints.	Section of Facility Operating Report used to comply with this permit term: (A) (Facility Identification) (B) (Deviations from permit requirements) (C) (Certification by Responsible Official) (D) (Complaint Response)
General recordkeeping requirements for compliance with 18 AAC 50.350(h) and 18 AAC 50.350(d)-(f) Permittee shall keep for not less than 5 years: - testing and monitoring information required by the permit, - copies of reports required by this permit, and other applicable data required by this permit as necessary to ascertain compliance with this permit. Keep a list of all deviations from permit conditions. Keep a log of all air pollution complaints received, investigations conducted to determine the cause of the complaints, and the actions taken to resolve the complaint.						
User fees 18 AAC 50.350(c), 18 AAC 50.400, 18 AAC 50.410, 18 AAC 50.420	Permit Condition The permittee shall pay emission and administration fees to the department as follows: (A) Calculate assessable emissions from fuel records from previous January 1 through December 31. Provide assessable emissions estimate to ADEC no later than March 31. (B) Send the calculations to Alaska Department of Environmental Conservation, Air Emissions Estimate, 410 Willoughby Avenue Suite 303, Juneau, Alaska 99801 (C) Use the emission factors and fuel ranges below to make the assessable emissions estimate: Fuel Consumption Gallons Multiply by Emission Factor yields Tons of Emissions 0 – 33096 zero zero assessable				Keep records of the quantity of commercial fuel and waste oil burned at the facility by month. The permittee may keep separate records of fuel burned in diesel engines and burned by other fuel combustion equipment.	

	33096 – 153846 0.000302 153846 – 281690 0.000367 281690 – 416666 0.000402 416666 – 476190 0.000426 Over 476190 0.000447 (D) Example: Last year your power plant consumed 300,000 gallons of diesel fuel. 300,000 gals x 0.000402 tons/gal = 120.6 tons 120.6 tons x $5.07 / ton = $611.44 emission fee Pay fees within 60 days of billing. (B) Permittee shall pay the permit administration fees in accordance with AS 46.14.240 and 18 AAC 50.400(a).			
Facility Operating Reports 18 AAC 50.350(i)(5) Permittee shall submit two copies and the original of semi-annual operating report to the Alaska Department of Environmental Conservation, Air Permit Program, 610 University Avenue, Fairbanks, Alaska 99709. The report is due by **February 1** and **August 1**. The reports are to contain the following information: (A) The name of the owner/operator, the facility name, and the period of the report; (B) identification of any deviation from the permit requirements: - a list of all periods of time when a permit condition was not complied with; - identification of that permit condition or other requirement; and - action taken to solve the problem; (C) a certification, signed by the Responsible Official defined in 18 AAC 50.990(77); (D) a list of all air pollution complaints received, results of investigations, and corrective actions taken; (E) a list of the fuel oil and used oil which were consumed for the past 6 months, for each calender month; (F) a list of fuel sulfur testing results for fuel and used oil consumed at the facility, by each calender month; (G) documentation of how the permittee complied with blending requirements for used oil; and (H) records of smoke/no-smoke visible observations, and copies of the Method 9 visible emission observation forms.			
Compliance Certification 18 AAC 50.350(j) The permittee shall certify compliance annually by February 1 of each year for the period from January 1 to December 31 of the previous year using the format specified in Attachment 2. The permittee shall submit a copy of an annual certification of compliance to EPA, Air Programs Administrator at 1200 6th Ave. Seattle, WA 98101, and two copies and the original to the Alaska Department of Environmental Conservation, Air Permit Program, 610 University Avenue, Fairbanks, Alaska, 99709.			

Excess emissions 18 AAC 50.350(i(1) A. Upon discovery of any excess emission in quantity or duration that is potentially injurious to human health, the permittee must immediately notify the Spill Prevention and Response Division of the Alaska Department of Environmental Conservation. The permittee shall send a signed AExcess Emission Notification Form@, Attachment 4 to ADEC within 24 hours of the discovery of the excess emission. **SPAR can be reached at the following numbers:** Central Alaska 269-7500 FAX 269-7648 Northern Alaska 451-2121 FAX 451-2362 Southeast Alaska 465-5340 FAX 465-2237 Outside of normal business hours: 1-800-478-9300 **The completed Excess Emission Notification form shall be faxed to the Anchorage Air Permits office at (907) 269 7508.** B. For excess emissions that do not fall into the above category, notify the Air Permit Program within 24 hours, or fax a copy of the Method 9 form.			

Basis for Permit Conditions, Monitoring, Recordkeeping, and Reporting

Condition numbers are those of the final draft permit.

Standard Permit Conditions

18 AAC 50.345(a) mandates standard permit conditions 1 - 14 for every operating permit.

Conditions 15 and 16 are federal regulations adopted by reference in 18 AAC 50.040.

Emission Limits

Conditions 17 - 19 reiterate the emission limits in 18 AAC 50.055(a)(1), (b)(1), and (c). These are also the approved SIP emission limits in the same portions of the former 18 AAC 50.050.

17. Opacity

Monitoring for the opacity limit in Condition 17 consists of two steps. These steps are to take into account the remoteness of rural electric generators, Method 9 certified readers to those locations, and the need for a program to detect engine deterioration. First, a non-certified reader would observe emissions from each stack for the first 30 days of operation. Second, if any smoke is observed, the operator would either repair the equipment to eliminate visible emissions within 72 hours, or do a Method 9 observation within ten days of the initial smoke detection. Then the 30 day observation period restarts. If no smoke is seen during the 30-day inspection period then the operator may do an inspection once a month to detect engine deterioration.

If the Method 9 readings are above 0 but below 12% opacity, the operator must continue to do Method 9 inspections for three consecutive operating days. If the opacity is still between 0 but less than 12%, the operator shall do monthly Method 9 readings. If for three consecutive months there is no opacity detected the permittee may start the 30-day smoke/no smoke inspection. If no smoke is detected then the operator continues with monthly smoke/no smoke readings and method 9 readings are not necessary. If the emissions are 12 but below 20% opacity at full capacity during the Method 9 readings, the source would be in compliance for opacity however there seems to be doubt whether the particulate matter standard would be met. The department believes this would be adequate to determine if an engine is deteriorating, and would limit the burden to operators. 72 hours is a reasonable amount of time for maintenance. If emissions were not eliminated in that time, there would still be time to arrange for a certified reader to come to the community within the allowed 10 days.

Method 9 forms and documentation of visible emission observations for presence or absence of smoke are part of the semiannual report (Condition R8).

18. Particulate Matter

The department does not intend to routinely require source tests for rural electric generators. However if the Method 9 readings show opacity greater than 12%, the department will require a Method 5 or other EPA approved method.

19. SO_2

Table 2 contains sample verification for two engines that 0.5% fuel sulfur would assure compliance with the 500 ppm SO_2 limit. In addition, Attachment 1 of this document is a interoffice memo showing the molar calculations for combustion using 0.5% sulfur diesel fuel.

Compliance will be verified through Conditions M7 and R2 by either fuel sulfur testing or verification of ASTM fuel grade. ASTM fuel specifications include fuel sulfur.

Used oil must be blended. Used oil does not normally exceed 0.5% sulfur. Blending will minimize the likelihood of any exceedence, while avoiding the cost of testing. Blending also limits the concentrations of other contaminant emissions. Conditions M8 and R3 - R5 provide records and reporting of compliance status.

20. Fuel Storage Tanks

The department expects some diesel fuel storage tanks will be subject to Kb recordkeeping. Condition 20 includes the necessary language.

Equipment standards or other control requirements of K, Ka, and Kb are not in the permit. Fuels used by these facilities are not likely to be volatile enough to be subject to those requirements. Facilities that are subject to them are barred from using the permit.

Prohibitions

21.1 Air Pollution Prohibited

18 AAC 50.110 contains the first half of this permit condition. The second part deals with complaint response. Section 50.110 issues are usually identified through citizen complaints. Therefore taking reasonable action to address complaints is the most appropriate way to assure compliance for issues that have not yet been identified.

Condition M6 stipulates complaint logs. A complaint log will enable the department to decide whether appropriate action was taken. The department will receive reports of the same information semiannually through Condition R8.

21.2 Dilution

This reiterates 18 AAC 50.045(e). Adequate monitoring would consist of a record of any deviation.

22. Fees

Fee equations are based on AP-42 emission factors for diesel engines. The permit also requires

payment of permit administration fees.

Calculation tables are provided to allow the selection of the correct emission factor based on the amount of fuel consumed. The fee calculation section is reproduced below.

Emission Calculations for Emission Fees

Calculate emissions from fuel records from previous January 1 through December 31. Make the calculations and provide assessable emissions estimate to ADEC no later than March 31.

Send calculations to

Alaska Department of Environmental Conservation
Air Emissions Estimate
410 Willoughby Avenue Suite 303
Juneau, Alaska 99801

Use the emission factors and fuel ranges in the following table to make the assessable emissions estimate:

Fuel Consumption gallons	Multiply By Emission Factor	Tons of Emissions
0 to 33096	Zero	Zero assessable
33096 to 153846	0.000302 tons/gal	
153846 to 281690	0.000367 tons/gal	
281690 to 416666	0.000402 tons/gal	
416666 to 476190	0.000426 tons/gal	
Over 476190	0.000447 tons/gal	

Example: Last year your power plant consumed 300,000 gallons of diesel fuel. You estimate as follows:

300,000 gals x 0.000402 tons / gal = 120.6 tons

120.6 tons x $5.07 / ton = $611.44 emission fee

Records and reporting of fuel consumption necessary to support fee calculations are stipulated in Conditions M3 and R6.

23. Compliance Certification

Condition 23 and Attachment 2 implement 18 AAC 50.350(j) and 18 AAC 50.205. Attachment 2 is

in a checklist format to make it simple for the permittee to complete. Semiannual reports sent to the department and records required to be kept on site will provide the background information the department needs to verify the assertions made in the compliance certification. The permittee must also certify that semiannual reports are true, accurate, and complete.

EE1 and EE2. Excess Emissions

To satisfy 18 AAC 50.235, 240 and 350(i) excess emissions and other deviations from permit conditions must be identified to the department. Excess emissions which are potentially injurious are to be reported upon discovery--other excess emissions within 24 hours. All deviations from the permit, whether or not they involve excess emissions are to be listed in the semiannual report.

TABLE 2

SO2 EMISSIONS AT 0.5% FUEL SULFUR.

From Caterpillar emissions data for 3412 DIT, 60 HZ

	bkw	g fuel/ bkw-hr	g fuel/hr [=bkw x (g fuel/bkw-hr)]	g SO2/hr [=g fuel/hr x %S x .02]	kg exhaust/hr	ppm SO2 [=1,000,000 x ((g SO2/hr)/(g mol wt SO2))/ ((kg/hr exh mass x 1000 g/kg)/g mol wt air)]
1800 RPM	588	234	137592	1375.92	3090	202
	559	231	129129	1291.29	2971	197
	504	227	114408	1144.08	2747	189
	419	226	94694	946.94	2392	179
	230	240	55200	552	1767	141
	140	266	37240	372.4	1560	108
	5	2846	14230	142.3	1371	47
1200 RPM	318	258	82044	820.44	1586	234
	255	244	62220	622.2	1327	212
	191	234	44694	446.94	1131	179
	127	244	30988	309.88	1015	138
	64	291	18624	186.24	946	89
	3	2678	8034	80.34	916	40

From Caterpillar emissions data for D399 PCTA PRECHAMBER ENGINE

	hp	lb fuel/hp-hr	g fuel/hp-hr	g fuel/hr [=hp x (g fuel/hp-hr)]	g SO2/hr [=g fuel/hr x %S x .02]	lb exhaust/hr	kg exhaust/hr	ppm SO2 (same as above)
1300 RPM	1287	0.39	177.06	227876.22	2278.7622	13421	6093.134	169
	960	0.38	172.52	165619.2	1656.192	10793	4900.022	153
	647	0.399	181.146	117201.462	1172.01462	8246	3743.684	142
	325	0.474	215.196	69938.7	699.387	6214	2821.156	112
	26	2.568	1165.872	30312.672	303.12672	5377	2441.158	56
			0					
			0					
1000 RPM	1090	0.385	174.79	190521.1	1905.211	9598	4357.492	198
	820	0.381	172.974	141838.68	1418.3868	7270	3300.58	195
	547	0.377	171.158	93623.426	936.23426	5569	2528.326	168
	275	0.424	192.496	52936.4	529.364	4659	2115.186	113
	20	2.29	1039.66	20793.2	207.932	3980	1806.92	52
			0					

ATTACHMENT 1

MEMORANDUM

State of Alaska

Department of Environmental Conservation
Division of Air and Water Quality - Air Quality Maintenance

TO: John Stone, Chief

DATE: March 24, 1998

FILE: 74.05.02

FROM: John Kuterbach
Air Quality Maintenance

SUBJECT: Maximum SO_2 Concentration from the combustion of #2 diesel fuel

EPA in their Title V permit reviews is requiring the department to demonstrate that limiting fuel sulfur to 0.5% will ensure compliance with our 500 ppmv SO_2 limit. This memorandum sets forth engineering calculations which demonstrate that combustion of #2 diesel fuel containing up to 0.5% sulfur will always comply with the 500 ppmv SO_2 limit regardless of the engine involved. I recommend that we reference these calculations in future "statements of basis" that we send to EPA with our draft operating permits.

Summary

This engineering calculation examined the stoichiometric combustion of #2 diesel fuel and calculated the maximum sulfur dioxide content of the flue gases. Typically, combustion of #2 diesel fuel can produce up to 338 ppmv SO_2 in the flue gas. Although this figure varies proportionally with the carbon content of the diesel fuel, the figure will never exceed the 500ppm limit.

I conclude that combustion of #2 diesel fuel with air will always comply with the 500ppmv emission limit. The ASTM specification for #2 diesel fuel limits sulfur to 0.5% or less.

Assumptions

All constituents of the fuel are burned proportionally
Any excess air typical of combustion would tend to dilute the SO_2 concentration in the flue gas, therefore only theoretical air is considered.
#2 diesel fuel is composed of Carbon, Hydrogen, Sulfur, and negligible amounts of Water and ash.
Ignore the water because the standard is a dry standard and the water will drop out of any calculations.
Ignore the ash as negligible unless the study predicts an SO_2 concentration greater than 450 ppm.
Typical #2 diesel fuel is composed of 87% Carbon, 12.5% Hydrogen, and 0.5% Sulfur
Calculations.

Using normal air for combustion (79% N_2 and 21% O_2):

For each lb-mole of Oxygen in Air, there is 3.76 lb-mole Nitrogen (1 lb-mole O_2) = (0.79/0.21) = 3.76 lb-mole N_2

The stoichiometric equations are:
$C + O_2 + 3.76\ N_2 = CO_2 + 3.76\ N_2$
$2H_2 + 0_2 + 3.76\ N_2 = 2H_2O + 3.76\ N_2$
$S + 0_2 + 3.76\ N_2 = SO_2 + 3.76\ N_2$

To calculate the dry exhaust gases (CO_2, N_2, SO_2) the following equations are used:

moles CO_2 = (lb C) x (1 lb-mole C/12.01 lb C) x (l lb-mole CO_2/1 lb mole C)
moles N_2 = (lb C) x (1 lb-mole C/12.01 lb C) x (3.76 lb-mole N_2/lb-mole C)
+ (lb H_2) x (1 lb-mole H_2/2.016 lb H_2) x (3.76 lb-mole N_2/2 lb-mole H_2)
+ (lb S) x (1 lb-mole S/32.06 lb S) x (3.76 lb-mole N_2/lb-mole S)
moles SO_2 = + (lb S) x (1 lb-mole S/32.06 lb S) x (lb-mole SO_2/1 lb-mole S)

Condensing these equations leaves:

moles CO_2 = lb C/12.01
moles N_2 = 3.76 x [(lb C/12.01) + (lb H_2/4.032) + (lb S/32.06)]
moles SO_2 = lb S/32.06

Then, by Avogadro's Law and the definition of mole:

ppmv SO_2 = 1,000,000 x [moles SO_2/(moles CO_2 + moles N_2 + moles SO_2)]

Results

Using 100 pounds of fuel as a basis, we examined the following three cases:

Case	Pounds in Fuel		
	Carbon	Hydrogen	Sulfur
1	87	12.5	0.5
2	96	3.5	0.5
3	78	21.5	0.5

Case 1 is the normal case, Case 2 increases carbon by 10 percent, and Case 3 decreases carbon by 10 percent.

	Case 1	Case 2	Case 3
moles CO_2	7.24	7.99	6.49
moles N_2	38.94	33.36	44.51
moles SO_2	0.0156	0.0156	0.0156
Total Dry Moles	46.196	41.366	51.016
ppmv SO_2	338	377	306

Conclusion

The above calculations show that #2 diesel fuel combusted with air will always comply with the 500 ppmv SO_2 limit. The calculations use the conservative assumptions of complete combustion and no excess air. The real-world includes partial combustion and excess air, both of which would tend to dilute the SO_2 concentration in the exhaust effluent.

The equations above can be used as an initial screening for other petroleum fuels even with a higher sulfur content or significant ash.

If you agree this memorandum has value, please share it with the rest of the AQM staff.